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Gülay SOYKÖK[1]
Rezzak YILMAZ[1]
Ahmet İlteriş ŞENTÜRK[2]
Şeyda ÇEVİK[3]
Şeyda FİGÜL GÖKÇE[1]
Özlem KAYIM YILDIZ[4]
Suat TOPAKTAŞ[4]

RESEARCH

ASSOCIATION OF SLEEP QUALITY AND DAYTIME SLEEPINESS WITH COGNITION IN THE ELDERLY

ABSTRACT

Introduction: The association between sleep problems and cognitive dysfunction is not reported in Turkey. The aim of the study was to evaluate the association between sleep quality and daytime sleepiness with cognitive functioning and to identify factors that influence cognitive state in the elderly.

Materials and Method: Using a simple random sampling method, 500 individuals, aged ≥60 years, living in the city of Sivas were recruited into our study. Standardized mini mental test, Pittsburgh Sleeping Quality Index and Epworth Sleepiness Scale tests were used to evaluate overall cognition, sleep quality, and daytime sleepiness, respectively.

Results: Lower cognitive functions were found to be significantly associated with age, female gender, living alone, low level of education and socioeconomic status. Impaired cognition was found in 53.8% of individuals with sleep quality disorder and 63.7% of individuals with daytime sleepiness ($p < 0.05$). According to logistic regression analysis, the risk of cognitive dysfunction in participants with a sleep quality disorder and daytime sleepiness were 4.17 and 3.48 times higher compared to individuals without the disorder respectively.

Conclusion: Sleep quality disorders were found to be prevalent in the elderly. A close relationship was found between cognitive dysfunction with poor sleep quality and daytime sleepiness.

Key Words: Aging; Sleep; Cognition.

ARAŞTIRMA

YAŞLI BİREYLERDE UYKU KALİTESİ VE GÜNDÜZ UYKULULUK HALİNİN KOGNİSYONLA İLİŞKİSİ

ÖZ

Giriş: Yaşlı bireylerde uyku problemleri ile kognitif bozukluk arasındaki ilişki Türkiye'de bildirilmemiştir. Çalışmanın amacı yaşlı bireylerdeki uyku kalitesi ve gündüz uykululuk halinin kognitif fonksiyonlar ile ilişkisini belirlemek ve yaşlıların kognitif durumlarını etkileyen faktörleri araştırmaktır.

Gereç ve Yöntem: Basit seçkisiz örnekleme yöntemi ile Sivas il merkezinde yaşayan 60 yaş ve üzeri toplam 500 birey çalışmaya alınmıştır. Veri toplama aracı olarak Standardize Mini Mental Test, Pittsburg Uyku Kalitesi İndeksi ve Epworth Uykuluk Ölçeği kullanılmıştır.

Bulgular: İleri yaş, kadın cinsiyet, yalnız yaşama, düşük eğitim düzeyi ve düşük sosyoekonomik düzey ile düşük kognitif fonksiyon arasında anlamlı ilişki bulunmuştur. Gece uyku kalitesi bozuk olan katılımcılarda kognitif fonksiyon bozukluğu olanların oranı % 53,8 bulunmuştur ($p<0,05$). Gündüz uykululuk hali olanlarda kognitif fonksiyon bozukluğu olanların oranı % 63,7'tür ($p<0,05$). Lojistik regresyon analizine göre, uyku kalitesi bozuk olanlarda kognitif fonksiyon bozukluğu olma riski olmayanlara göre 4,17 kez fazla bulunmuştur. Gündüz uykululuk hali olanlarda kognitif fonksiyon bozukluğu görülmesi riski olmayanlara göre 3,48 kez fazla bulunmuştur.

Sonuç: Yaşlı bireylerde uyku kalitesinde bozukluk sıktır. Uyku kalitesi kötü olan ve gündüz uykululuk hali yaşayan yaşlılarda kognitif fonksiyon bozukluğunun daha fazla olduğu saptanmıştır.

Anahtar Sözcükler: Yaşlılık; Uyku; Kognisyon.

Correspondance

Gülay SOYKÖK
Numune Training and Research Hospital, Department of Neurology, SİVAS

Phone: 0346 444 44 58
e-mail: drgulayuzun@gmail.com

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[1] Numune Training and Research Hospital, Department of Neurology, SİVAS
[2] İstanbul University, Cerrahpaşa Medical Faculty, Department of Algology, İSTANBUL
[3] Necip Fazıl Hospital, Department of Neurology, KAHRAMANMARAŞ
[4] Cumhuriyet University, Faculty of Medicine, Department of Neurolgoy, SİVAS

INTRODUCTION

Sleep is an active process that is structured into cycles of various psychophysiological states. It ensures the normal functioning of the endocrine and immune systems, regulates the mood, and affects the mental and cognitive functions (1). Sleep consists of periodic transitions between wakefulness and five sleep periods. Rapid eye movement (REM) sleep is thought to play a role in the restoration of the brain, whereas non-REM (NREM) sleep is responsible for restoration of vegetative somatic tissues. When REM sleep is deprived, intense REM for the consecutive nights is necessary to cope with the deficiency of the previous night's sleep (2).

The REM period, during which 80% of dreams occur, regulates cognitive processes, especially the memory function (2). In individuals trained on a new task, the REM period was noted to increase at night. If REM sleep deprivation occurred after the training on a new task, it was found that no stored information about the task emerged the next day. This was especially true if the second period of REM sleep was blocked; a deterioration of memory occurred (3).

The structure and the activity of sleep change with advancing age. More awakenings occur during the night; therefore, daytime sleepiness may increase. Because of the sleep-wake cycle, the sleep pattern is usually partitioned (4). In elderly individuals, NREM sleep phase I and II increase, whereas REM sleep decreases (5). Depending on the reduction of total sleeping time at night, periods of REM reduce and the transition latency to the first REM phase shortens (6).

In the elderly, inadequate and ineffective sleep may cause depression or anxiety, reducing the quality of life, or even may increase the rate of morbidity and mortality. Impaired sleep may also cause imbalances and limitations in movement that increase the risk of falling and admission to residential care facilities (7,8). Compared to the control group, patients with sleep disorders have been shown to have cognitive difficulties such as prolonged reaction time, memory dysfunction, and attention problems (9). The open-ended research question is that to what extent are the sleep quality and daytime sleepiness associated with the cognitive impairment? As far as we are aware, there has been no study about this issue reported from Turkey. Therefore, we attempted to investigate the relationship of sleep quality and daytime sleepiness with cognitive functions in the elderly population, aged ≥60 years.

MATERIALS AND METHODS

In this study, a simple random sampling method was used to select and enroll the participants, representing the elderly population of Sivas Province, for face-to-face interviews. To compensate for the socioeconomic status, different numbers of elderly people from various neighborhoods were included. The study was performed between January 2010 and January 2011 after obtaining the administrative permissions and approval by the local ethics committee. Individuals with speech disorders and severe vision or hearing deficits were excluded from the study.

In total, the study group comprised 500 people, aged ≥60 years. Informed and written consent was obtained from each participant or (for those who cannot write) the participant's closest relative before the study. The various assessment scales were administered and evaluated by the same clinician throughout the study.

Data Collection Tools

Socio-demographic Form

A form was used to obtain socio-demographic data of all the participants, including age, gender, marital status, education level, occupation, socioeconomic status, presence or absence of people living together, chronic diseases, and drug use. The economic status was assessed by their monthly income.

The Standardized Mini Mental Test (SMMT)

The SMMT was used to assess overall cognition. This test was developed for the first time by Folstein *et al*. (10). The validity and reliability of this scale for the diagnosis of mild dementia among the Turkish population has been shown by Güngen *et al*. (11). The SMMT scale consists of 11 sub-tests that measure orientation, registration memory, attention and calculation memory, and language and structure skills; the scores of which can add up to a maximum of 30 points. The SMMT was used in two different forms for educated (at least 5 years of education) or uneducated, according to the participants' educational background. A score of 25 points and below was considered as an indicator of cognitive dysfunction.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI was used to assess the quality of sleep. This scale was developed by Buysse *et al.* (12). The reliability and validity of this scale for the Turkish population was reported by Ağargün *et al.* (1). The PSQI evaluates the quality of sleep at night within the last month and has seven components: subjective sleep quality, sleep latency, sleep duration, habitual

sleep efficiency, sleep disturbances, use of sleeping medication, and daytime functions. Some components were measured using a single item, and some were obtained by grouping several items. Each item was evaluated on a scale of 0–3. The total score can be a value between 0 and 21. A total PSQI score above 5 indicates poor sleep quality.

Epworth Sleepiness Scale (ESS)

The ESS was developed in 1991 by M. W. Johns (13) and was shown to be a valid and secure test in a study on sleep disorder among the Turkish population (14). The ESS is a four-point Likert-type scale, each score ranging from 0 to 3, where high scores indicate sleepiness. With the ESS, a person can receive a total score between 0 and 24, and scores > 10 indicate daytime sleepiness.

Statistical Analysis

Descriptive data were given as mean ± standard deviation (SD). Differences between the categorical variables were analyzed using Pearson Chi-square test. Correlation between the scores of the tests (for non-normally distributed data) was investigated by using a Spearman's test. The influence of covariates of age, sex and education on cognitive test score is analyzed by multiple regression model. Association between dependent and independent variables was analyzed by using logistic regression. A p value <0.05 (two-sided) was considered as statistically significant. The statistical analyses were performed by SPSS version 14.0 (Statistical Packages for the Social Science) program.

RESULTS

The research cohort was made up of 500 individuals whose mean age was 68.85±6.8) years, with 258 (51.6%) females and 242 (48.4%) males. The mean age of female participants was 68.35±6.8 years and that of male participants was 69.38±6.8 (p=0.09). Among the total participants, 181 were not literate, 272 participants graduated from primary school, and 46 had higher education. Only four of the study participants were still working and the remaining was retired or unemployed.

Of the investigated cohort, 37.8% (n=189) were found to have cognitive dysfunction. The mean age (72.04±7.07 years) of participants with cognitive dysfunction was found to be significantly higher when compared to those without cognitive dysfunction (66.9±5.3 years) (p=0.001). In addition, age, female gender, low education and socioeconomic status, lack of social support, and living alone were observed to be significantly associated with poor cognitive performance (p<0.01). The demographic characteristics of the cohort are depicted in Table 1.

Examination of the PSQI global scores of the participants showed that 63.2% of the participants (n=316) were found to have an index score of ≥5, indicating poor sleep quality; whereas 36.8% of the participants (n=184) had an index score of <5, indicating good sleep quality. Of the participants with poor sleep quality, 53.8% (n=170) were found to have cognitive dysfunction and 46.2% (n=146) had normal cognitive functions, whereas in those with good quality of sleep, 89.7% (n=165) had normal cognitive functions. Accordingly, participants with impaired sleep quality performed significantly worse than the participants with good sleep quality with regard to cognitive functions (p=0.001) (Table 2). Multiple regression analysis by using hierarchical entry showed that PSQI explains the significant amount of variance in the cognitive outcome in the presence of age, sex and education as covariates (Table 3).

Regarding the ESS score, the study showed that 42.4% (n=212) of the participants had an ESS score >10, indicating daytime sleepiness, and 57.6% (n=288) had no daytime sleepiness. Analysis of these scores with regard to cognitive dysfunction showed that 63.7% of the participants (n=135) with daytime sleepiness were characterized to have cognitive dysfunction, and 36.3% of the participants (n=77) had no cognitive dysfunction. Approximately81.3% of the subjects (n=234) without daytime sleepiness were found to have normal cognitive functions (p=0.001) (Table 4). As shown in multiple regression analysis by using hierarchical entry, ESS predicted the significant amount of change in the dependent variable along with age and education (Table 5).

According to the logistic regression analysis, both the tests of sleep quality and daytime sleepiness were associated with cognitive performance, with PSQI showing the strongest association. In addition, individuals with a PSQI score ≥5 showed an increased risk for concomitant cognitive dysfunction about 4.17 (2.32 to 7.48) times higher than those with PSQI <5. In participants with an ESS ≥10, the logistic regression analysis predicted the risk of cognitive dysfunction to be 3.48 (2.18 to 5.54) times higher than in those with an ESS <10 (Table 6). Spearman's correlation analysis also showed a strong positive correlation between PSQI and ESS (r=0.51, p<0.0001).

Table 1— Demographic Data of the Participants According to the Distribution of Cognitive Functions.

Parameters	Low SMMT		Normal SMMT		Total	χ^2	p
	n	(%)	n	(%)	n		
Sex							
Female	113	(43.8)	145	(56.2)	258	8.15	0.004
Male	76	(31.4)	166	(68.6)	242		
Marital status							
Married	110	(33.0)	223	(67.0)	333	9.63	0.02
Single	79	(47.3)	88	(52.7)	167		
Education level							
Illiterate	99	(54.7)	82	(45.3)	181	43.2	0.001
Literate	41	(38.3)	66	(61.7)	107		
Primary	41	(24.8)	124	(75.2)	165		
High School	8	(19.5)	33	(80.5)	41		
University	0	(0)	6	(100)	6		
Occupation							
Employed	0	(0)	4	(100)	4	13.0	0.001
Unemployed	114	(45.1)	139	(54.9)	253		
Retired	75	(30.9)	168	(69.1)	243		
Socioeconomic level							
Low	88	(46.8)	100	(53.2)	188	10.5	0.005
Middle	72	(33.2)	145	(66.8)	217		
High	29	(30.5)	66	(69.5)	95		
Status of living							
None	18	(56.2)	14	(43.8)	32	10.8	0.01
With wife	78	(32.8)	160	(67.2)	238		
With children	60	(45.1)	73	(54.9)	133		
With wife and kids	33	(34.0)	64	(66)	97		
Total	189	(37.8)	311	(62.2)	500		

SMMT = Standardized mini mental test.

Discussion

Most of the elderly individuals in our study (63.2%) were found to be lacking good sleep quality. In addition, in individuals with impaired sleep quality, the risk of accompanying cognitive dysfunction was found to be greater than in those with normal sleep quality. The SMMT score of the elderly seemed to decrease as sleep quality deteriorated. When daytime sleepiness was analyzed, individuals with daytime sleepiness showed significantly greater cognitive dysfunction than those without. The majority of individuals without daytime sleepiness showed normal cognitive functions.

The prevalence of insomnia increases with age; most of the elderly have one or more complaints related to sleep, such as difficulty in falling asleep, daytime sleepiness, not feeling rested, or early waking (15). In a study of > 9,000 people above the age of 65 years, 28% of the participants reported difficulties in falling asleep and 42% had difficulties in both falling asleep and sustaining sleep at night (15). In our study, this percentage was higher (63.2%) showing that the majority of elderly have poor sleep quality. Cricco *et al.* (16) and Meguro *et al.* (17) also reported a similar relationship between sleep disorders and cognitive functions in the elderly. Cognitive functions are impaired in elderly individuals who complain of persistent insomnia and impaired sleep-wake cycle. In addition, poor sleep can be a prodromal marker of neurodegenerative disorders such as Parkinsonism (18) or can accelerate morbidity in the course of Alzheimer's disease (19).

In our study, the relationship between daytime sleepiness and cognitive function was also investigated. Excessive dayti-

Table 2— PSQI Distribution of Values According to the Cognitive Assessment.

Status	PSQI score 5 and <5	PSQI score >5	Total
Cognitive Functions Non-impaired n (%)	165 (89.7)	146 (46.2)	311 (62.2)
Cognitive Function Impaired n (%)	19 (10.3)	170 (53.8)	189 (37.8)
Total	184	316	500

PSQI= Pittsburgh Sleep Quality Index, p=0.001.

Table 3— Multiple Regression Analysis of PSQI With Age, Sex and Education as Covariates.

Variable	Model 1			Model 2		
	B	SE	Beta	B	SE	Beta
Age	-0.2	0.02	-0.38*	-0.18	0.02	-0.32*
Sex	0.4	0.35	0.05	-0.1	0.34	-0.2
Education	0.8	0.17	0.22*	0.8	0.16	0.22*
PSQI				-0.21	0.03	-0.28*
R2			0.24		0.31	

* P< 0.0001

me sleepiness contributes to high morbidity through life-threatening accidents, reduced labor productivity, and impaired psychosocial functioning. Elderly people have difficulty in staying awake during the day compared to young people; thus, daytime sleepiness complaints may be increased. Foley *et al.* (20) reported in their 3-year prospective study, which examined the relationship between sleep disorders and dementia in the elderly, that individuals who complain of excessive daytime sleepiness have an incidence of dementia two times greater than those without daytime sleepiness. Moreover, Ohayon and Vecchierini (21) found that elderly individuals

Table 4— ESS Distribution of Values Based On Cognitive Functions.

Status		ESS Score ≥10	ESS Score <10	Total
Cognitive Functions Non-Impaired	n (%)	77 (36.3)	234 (81.3)	311 (62.2)
Cognitive Functions Impaired	n (%)	135 (63.7)	54 (18.7)	189 (37.8)
Total		212	288	500

ESS=Epworth Sleepiness Scale, p=0.001.

Table 5— Multiple Regression Analysis of ESS With Age, Sex and Education as Covariates.

Variable	Model 1			Model 2		
	B	SE	Beta	B	SE	Beta
Age	-0.21	0.02	-0.38*	-0.16	0.02	-0.29*
Sex	0.4	0.35	0.53	0.4	0.33	0.05
Education	0.8	0.17	0.22*	0.74	0.16	0.2*
ESS				-0.24	0.03	-0.3*
R2		0.24			0.31	

*P<0.0001

Table 6— Coefficients of the Independent Variables and Odds Values According to Logistic Regression Analysis.

Variables	Beta	SE	p	EXP (Beta) ODDS	95% CI
PSQI (1)	1.42	0.29	0.001	4.17	2.32–7.48
ESS (1)	1.24	0.23	0.001	3.48	2.18–5.54
Stable	-1.40	0.30	0.001		

PSQI (1): Index score of ≥5, with impaired sleep quality group.
ESS (1): Scale score ≥10, day sleepiness group.

who slept<6 h a night and had a daytime sleepiness lasting more than an hour were cognitively impaired. Our results are in accordance with these previous reports. Daytime sleepiness is also associated with reduced social and cognitive stimulation, and the rate of cognitive dysfunction was found to be higher in elderly with decreased cognitive stimulus and social activities (22). Particularly, intellectual stimulation and social integration may be helpful for alleviating daytime sleepiness in the elderly (23).

People with sleep disorders may be at risk for potential cognitive dysfunction as well as late-onset depression, which can play a role in cognitive function. However, according to the study conducted by Cricco *et al.* (16), sleep quality disorder was found to be an independent risk factor for cognitive impairment in males.

In our study, a higher rate of cognitive dysfunction was also found to be associated with lack of social support and living alone, both in the elderly and in women. The low level of education and insufficient social integration due to isolation could explain why cognitive dysfunction was found to be more common in women.

Our goal was to investigate the association of sleep disorders with cognitive impairment. We assessed sleep disorders by using the PSQI and ESS subjectively and showed the association with cognitive dysfunction. The results are consistent with other studies based on the association of sleep complaints with cognition in the elderly.

The main shortcoming of our study is the lack of assessment of depression, which is a factor that can cause sleep disorders as well as cognitive impairment. In addition, the majority of study participants had a low level of education, which may raise doubts about the reliability of the data. For the latter reason, assessments were conducted by a single evaluator during the face-to-face interviews to obtain standardized data. Despite these weaknesses, the strength of the rating scales and the large number of study participants increase the reliability of the data obtained. To our knowledge, our study is the first in Turkey to show a relationship of sleep disorders with cognition among the elderly, by using a two-way evaluation. Our study proves that there is a significant association between these two conditions, without investigating a cause-and-effect relationship. In elderly individuals with daytime sleepiness, cognitive impairment should be kept in mind as an accompanying factor. Further studies are needed to validate the relationship between sleep quality and cognitive performance in elderly populations with more participants and including individuals with depression.

Conflict of Interest

The authors state that there is no conflict of interest.

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